Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00178

Polymer Membranes for High-Temperature PEM Fuel Cells and Solid Polymer Batteries

Technology

The National Aeronautics and Space Administration (NASA) seeks to transfer technology for the development and production of a series of organically modified silicates (ORMOSILs) for a wide variety of applications. These materials form dimensionally, mechanically, and thermally stable films with good ion conduction over a wide range of temperatures.

Benefits

- Simple fabrication
- Dimensionally stable, flexible films
- Good ion conductivity over a wide range of temperatures
- High pressure not required

Commercial Applications

- Fuel cells
- Batteries
- Sensors
- Gas separation
- Electrochemical capacitors
- Electrochromic windows or displays

Technology Description

Clean, efficient, renewable energy from batteries and fuel cells are increasingly gaining the public's attention for reducing reliance on fossil fuels. However, current battery and fuel cell technologies do not meet the performance or durability requirements for use in demanding applications such as vehicles, space exploration equipment, and heavy machinery.

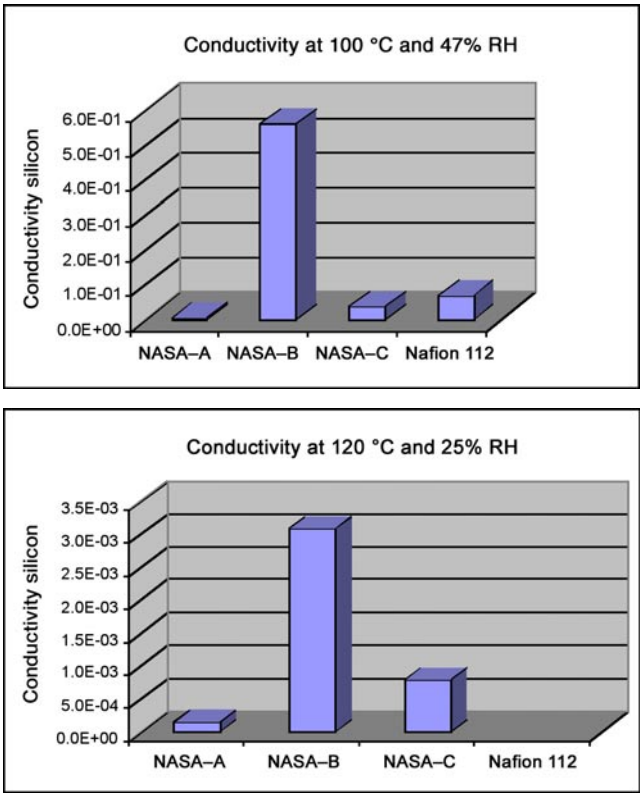

Figure 1–NASA GRC's ORMOSILS have good proton conductivity at 120 °C and low relative humidity.

ORMOSILs have received considerable attention recently as gas separation membranes, solid electrolytes for lithium batteries, and proton exchange membranes (PEMs) for fuel cells. Many of these ORMOSILs are formed by the sol-gel process. By synthesizing organofunctionalized silanes, films can be produced with a wide variety of properties.

NASA Glenn Research Center (GRC) has developed a series of ORMOSILs with acceptable ionic conductivity as well as thermal and dimensional stability that have applications as a proton-conducting membrane for PEM fuel cell applications. The

membranes are synthesized using the sol-gel process. A variety of films have been synthesized and the proton conductivity of these films has been measured at 120 °C and 25 percent relative humidity. Proton conductivities as high as 1×10^{-2} S/cm have been attained. A series of films were also produced that contained various concentrations of Nafion blended into the films. Single-cell fuel cells using these ORMOSIL membranes is currently being investigated.

Figure 2–The ORMOSIL is a flexible and mechanically robust, low-cost membrane.

In addition to use in fuel cells, lithium or lithium salts can be incorporated into these ORMOSIL films for use as a solid polymer electrolyte in lithium batteries. Solid electrolytes have been constructed using an ORMOSIL film that not only had good ionic conductivity but also demonstrated good performance in a lithium battery test cell. Further, these materials can decrease the operating temperature and improve energy density in lithium-polymer batteries. They may also eliminate the need for solvent in typical battery applications improving safety and environmental impact, and simplifying battery construction.

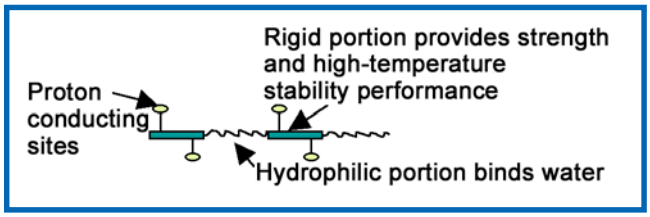

Figure 3–The ORMOSIL is designed for efficient proton conduction and moisture retention.

Many types of organic or inorganic additives can be incorporated into the unique molecular structure of these ORMOSILs, further improving the performance for any given application.

NASA Glenn's ORMOSILs are made from relatively low cost materials resulting in an overall cost reduction of 10 to 20 times that of the current state-of-the-art fuel cell membrane. The synthesis is versatile, making these materials customizable to your application.

Options for Commercialization

NASA Glenn Research Center is interested in working with industry and academia to further develop this material and identify new applications for polymer membranes for high-temperature PEM fuel cells.

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References

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Key Words

Organic
Polymer
Composite
Inorganic
Silica
Fuel cell
PEM
Lithium
Battery